Mortality Among Kitchener Fire Fighters and Waterloo Regional Police Officers From January 1, 1973 to December 31, 1990 with Special Reference to The Fire at Horticultural Technologies Limited on March 6, 1987

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Executive Summary

On March 6, 1987 firefighters from the Kitchener Fire Department were dispatched to a fire at Horticultural Technologies Limited (HT) on Hansen Avenue in Kitchener. This company manufactured cut flower foods, floral aerosol, and horticultural foam for the greenhouse and flower industries and the plant contained a wide variety of materials including foams, inks, dyes, adhesives, and aerosol paints. Seventy one firefighters were involved in firefighting operations and 19 police officers from the Waterloo Regional Police Force were called to the scene to perform such duties as traffic control.

In the 3 years following the fire, 2 firefighters who had been in attendance died of cancer, and another firefighter and a police officer were diagnosed with cancer. The men became worried that exposures at the fire scene were responsible for the tumours and approached several occupational physicians and the Ministry of Labour with their concerns. They were advised that the short period of time between the fire and the development of disease made it unlikely that there was a cause and effect relationship, and, that the small number of men involved would almost certainly make any investigation inconclusive. It was agreed, however, that the Ministry of Labour would undertake an investigation of the health experience of the firefighters and police officers. It was agreed that there would be a 2-phased approach to the investigation. The **first phase** would examine the cancer experience of the Fire and Police Departments, with particular reference to attendance at the Horticultural Technologies fire. The **second phase** would involve administration of a questionnaire to investigate the current health status of members of the 2 forces in order to compare the current health of men who had been present at the fire with the health of those men who had not been present. This report presents the results of Phase 1 of the investigation. A report on Phase 2 will follow.

International experience with the effects of cancer causing agents (carcinogens) has indicated that there is usually an interval of 10 years or more between exposure to a carcinogen and death from cancer. This pattern suggested that the time since attendance at the HT fire might be too brief to account for the cancer experience of the men at the fire, and that this fire might simply have been an event which drew attention to the result of exposures to combustion products occurring earlier in the men's careers.

The goals of the study were thus to: 1) examine the mortality experience of the firefighters over as long a time frame as possible in order to look for an association between a career as a firefighter and an increased risk of cancer; 2) compare the firefighters' cancer experience in the period after the HT fire with their cancer experience before the HT fire; 3) compare the cancer rates of those in attendance at the HT fire with the cancer rates of those not in attendance; and, 4) search for any associations between activities at the fire scene and the risk of developing cancer.

The study population consisted of 227 firefighters and 706 police officers on the Departmental rolls on or after January 1, 1973. Vital status of the men was determined from Departmental reports of status, and by searches at the Driver Licence Registry of the Ministry of Transport, the Ontario Cancer Registry, and the Canadian Mortality Database at Statistics Canada. Mortality rates among the firefighters and police officers were compared with each other as well as with rates among the general male population of Ontario.

In relation to the goals of the study, the findings were as follows:

1) Examine the mortality experience of the firefighters over as long a time frame as possible in order to look for an association between a career as a firefighter and an increased risk of cancer:

During the period of observation, 1973-1990, overall mortality rates among officers in the fire and police Departments *were substantially less than the Ontario average*. Mortality rates from cancer were close to the Provincial average. Among firefighters, mortality from circulatory and respiratory diseases was substantially below the Provincial averages. Among police officers mortality rates from circulatory disease were close to the Provincial average; low mortality in the period up to 30 years from hire was offset by above average mortality in the period 30 or more years after hire. Deaths from violent causes were less than the Provincial average in both Departments. Three firefighters died from violent causes; one man was killed in the line of duty. Three police officers died from violent causes; none was killed while on duty.

2) Compare the firefighters' cancer experience in the period after the HT fire with their cancer experience before the HT fire and 3) compare the cancer rates of those in attendance at the HT fire with the cancer rates of those not in attendance:

Mortality among the men present at the HT fire was higher than the Provincial average because of the cancer deaths which initiated this investigation. All 4 of the deaths among the men at the fire were from cancer. Three cancer deaths occurred among the firefighters present at the fire, a rate 10 times higher than the Ontario average. In only one case was the type of cancer reliably determined. One police officer died of cancer, once again a rate substantially higher than the Ontario average. Among men not present at the HT fire, mortality continued to be less than the Provincial average.

4) Search for any associations between activities at the fire scene and the risk of developing cancer.

Many of the men present at the HT fire had completed an exposure report for the Fire Fighters Association. These reports were used in an attempt to identify any fire-related factors which might be associated with the development of cancer following the fire. Assessment of any differences in exposures or activities at the HT fire between those men who developed cancer and those who did not is severely hampered by the small size (from a statistical viewpoint) of the crew at the HT fire. *Although some differences emerge from the analysis, coincidence is always a viable explanation because changing the "exposure status" of only one cancer victim would cause the differences to disappear.*

One might presume that men involved with overhaul operations might have had higher exposure to products of combustion than men not engaged in these operations because smouldering debris continues to give off fumes and because firefighters often do not wear respiratory protection during this phase of the firefighting operation. Three of 38 men who were

involved in overhaul operations developed cancer, while none of the 30 men who were not involved in overhaul operations died from cancer. The probability of a difference this large happening by coincidence is 16%.

It was also found that men who reported irritative symptoms such as burning eyes, cough, and nose/lung irritation were more likely to develop cancer than men who did not report these symptoms. These symptoms are consistent with substantial exposure to combustion fumes, but once again the differences are compatible with coincidence. It should also be noted that while some men reported other potentially exposure-related symptoms such as nausea, dizziness, headache, and skin irritation, none of the cancer victims reported these symptoms.

A major concern of the men at the fire was exposure to the chemicals stored at the HT plant. Shortly after the fire an inventory of chemicals was compiled and Material Safety Data Sheets for the products in use were obtained from the Company. The Fire Department determined that much of the chemical inventory was in storage locations where it was not damaged by the blaze. It was concluded that the materials that were involved in the fire were as follows:

- A couple of drums of Freon 11;
- Less than 1 drum of phenolsulfonic acid, which had been hooked up to a mixer;
- Seven drums of surfactant, an alcohol type wetting agent;
- The remaining substance involved in the fire, other than the building materials themselves, was a large amount of the finished product, a wet and dry foam called Oasis.

Assessment of the hazard posed to firefighters by these compounds is difficult because there is no measure of exposure of the officers to any of these compounds or to their thermal decomposition or combustion products, some of which may be substantially more toxic than the original compounds. For example, Freon 11 is used as a foaming agent. It has very low toxicity, and has been used as a propellant in canisters of asthma medication. In contact with flame, however, it may be converted to phosgene gas, a severe respiratory irritant, which can lead to death by respiratory failure. Freon 11 has been tested for carcinogenicity in rats and mice, and has been negative in both species.

Phenolsulfonic acid is used in the manufacture of foams. Its boiling point is 212 °F, so that it is likely to have vaporized in the fire. There is little information about its toxicology. Poisonous vapours are produced in fire, and its decomposition products include phenol vapours, oxides of sulphur, as well as carbon monoxide and carbon dioxide. Phenol is a potent irritant, but is not a recognized carcinogen. Sulphur oxides are also respiratory irritants, but are not recognized carcinogens.

According to the Material Safety Data Sheets, the surfactant mixture contained mixtures of sodium salts of organic acids plus organic esters, in additional to isopropyl alcohol (rubbing alcohol). The boiling point is 180 °F. Oxides of sulphur, as well as carbon monoxide and carbon dioxide may be present in the combustion products. Organic esters are not recognized as carcinogenic substances.

The decomposition products of the Oasis foam may include phenol, formaldehyde, acrolein, and carbon monoxide. Formaldehyde is capable of inducing nasal cancers in experimental animals and is a suspect carcinogen of the human respiratory tract. Acrolein may cause severe irritation of the eyes and lungs. It is not a recognized human carcinogen.

In summary, we have found that in the period 1973 to 1990, Kitchener firefighters and Waterloo Regional Police officers have had a better than average mortality experience, that is, their life expectancies have been longer than that of the average man in Ontario. This finding is to be expected, since passing a test of physical fitness is required in order to join the forces. During this same period, cancer mortality rates have been about the same as the Ontario average, and were similar for members of both forces.

The major focus of attention has been the deaths from cancer since the Horticultural Technologies fire in March, 1987. This analysis has confirmed that men in attendance at the fire have had a substantially higher cancer risk than was observed either before the fire or among men who were not in attendance at the HT fire.

There are 3 plausible explanations for the cancer deaths among the men at the HT fire which should be considered here:

1) These deaths were related to occupational exposures occurring prior to the HT fire, which served only to draw attention to cancer risk among firefighters;

2) These deaths were caused or accelerated by exposures received at the HT fire;

3) These deaths were unrelated to occupational exposures and their apparent relation to the HT fire is coincidental.

1) Causation by Earlier Exposures

The unusually short interval between the HT fire and death from cancer, as well as the brevity of the exposure there, suggested that perhaps earlier exposures incurred over a firefighting career might have been responsible for these deaths. The results of the study indicate that from January 1,1973 to December 31, 1990 Kitchener firefighters had a cancer risk that was equal to the Ontario average and that there was essentially no difference between the cancer risk of firefighters and police officers. The question whether firefighters are at increased risk of cancer has attracted much scientific attention in recent years. Some studies found risks slightly higher than average, while others found risks slightly lower than average. Combining the results of all of them we find that firefighters have had the same risk of death from cancer as the general population of their jurisdictions. The Kitchener firefighters, overall, have had an experience consistent with this pattern. *It is thus concluded that the cancers occurring after the HT fire are not likely attributable to exposures occurring earlier in the firefighters' careers.*

2) The HT Fire as a Causative Factor

As discussed above, during the period 1973-1990 firefighters and police officers had a cancer mortality risk similar to the Ontario average. Nevertheless, the risk was lower than average before the HT fire and it remained lower than average for those men who were not present there, while the cancer risk was higher than average in the years after the HT fire for those men who were present. This pattern is compatible with the effect of HT fire-related exposures, but is not proof that these exposures were the cause of the deaths. We found that men involved in overhaul operations at the fire had a higher risk of cancer than men not so involved, and that men who reported certain irritative symptoms had a higher risk of cancer, but the number of cancer deaths was small and these differences are compatible with chance. The

major arguments against there being a causal connection are the short latency and the probability that chemical exposures, although unmeasured, were low in comparison to those which occurred in industrial settings where it commonly took years of exposure before cancer risk was measurably increased. *We conclude that it is not possible to convincingly confirm or refute the possibility that unmeasured chemical exposures at the HT fire were in some way responsible for the cancer deaths occurring among the men in attendance at the fire.*

3) Coincidence

Cancer mortality rates were substantially higher among exposed firefighters and police officers. This is an unusual occurrence, but is not incompatible with coincidence. It will not be possible to decide for or against coincidence until additional time has passed. Should the cancer rate return to normal in the years to come, then it will become more likely that the occurrence of the cancer deaths among men at the HT fire was a tragic coincidence.

There are several social consequences connected to the assessment of whether or not these deaths are related to exposures at the HT fire. Firstly, a number of compensation claims have been filed with the Workers' Compensation Board. It is the responsibility of Compensation Board officials to make a determination of compensability in each of these cases, and no additional comment is made in this report. Secondly, there is the problem of anxiety among other officers present at the HT fire, and the associated issue of medical surveillance for the early detection of health problems possibly associated with attendance at the fire. Of the several possible explanations for the cancer cluster after the fire, it might prove best for peace of mind to accept coincidence as the best explanation until there is good reason to think otherwise. Medical screening has not been found to be valuable in the detection of the types of tumours which have occurred since the fire, and there are very few cancer screening modalities which are of demonstrated value in men. Special medical surveillance of the men in attendance at the HT fire is thus *not recommended* at this time.

It is proposed that the Ministry of Labour remain in contact with the forces, and that the analysis of the cancer experience be updated in several years time. Should the cancer risk return to its baseline value, this will suggest that coincidence was indeed the correct explanation.

Introduction

On March 6, 1987 firefighters from the Kitchener Fire Department were dispatched to a fire at Horticultural Technologies Limited (HT) on Hansen Avenue in Kitchener. This plant manufactured cut flower foods, Floral Aerosol, and horticultural foam (Oasis material) for the greenhouse and flower industries. The company also distributed aerosol paints to these industries and the plant contained a wide variety of materials including foams, inks, dyes, adhesives, and aerosol paints. Platoon B-2 responded initially to the fire, and called in off-duty personnel to assist in the fire fighting operations. Platoon A-2 performed the overhaul and salvage work at the scene after relieving Platoon B-2 and the off-duty personnel. Seventy one firefighters were involved in these operations. In addition to the firefighters, 19 police officers from the Waterloo Regional Police Force were called to the scene to perform such duties as traffic control.

In the 3 years following the fire, 2 firefighters who had been in attendance died of cancer, and another firefighter and a police officer were diagnosed with cancer. The men became concerned that exposures at the fire scene were responsible for the tumours. The Kitchener Professional Fire Fighters Association contacted several occupational health physicians for advice. They were told that the short period of time between the fire and the development of disease made it unlikely that there was a cause and effect relationship. In addition, they were advised that the small number of men involved would almost certainly make any investigation inconclusive.

On April 30, 1990 representatives of management and officers from the Kitchener Fire Department and the Waterloo Regional Police Force, accompanied by the MPP for Kitchener, met with officials from the Ministries of Labour and the Solicitor General. They explained that the men were nervous about the apparent risk to their health. In addition to the men with cancer, there was worry about others who had developed Parkinson's disease, gastrointestinal complaints, and fainting spells.

The concerns were discussed at the meeting, and it was again pointed out that historical experience has indicated that it generally takes 10 or more years after a toxic exposure for deaths from cancer to occur. It was agreed however, that the Health and Safety Studies Service of the

Ministry of Labour would undertake an investigation of the health experience of the firefighters and police officers. It was agreed that there would be a 2-phased approach to the investigation. The **first phase** would examine the cancer experience of the Fire and Police Departments, with particular reference to attendance at the Horticultural Technologies fire. The **second phase** would involve administration of a questionnaire to investigate the current health status of members of the 2 forces in order to compare the current health of men who had been present at the fire with the health of those men who had not been present.

This report presents the results of Phase 1 of the investigation. A report on Phase 2 will follow.

Description of the Fire and Building Contents

The following description of the circumstances of the fire is taken from a report prepared by the Kitchener Fire Department in March, 1987.

The fire alarm was received at the Fire Department at 01:03 hours on March 6, 1987. A 2 station response was dispatched, but eventually 4 stations were at the scene along with 17 off duty personnel. Waterloo Regional Police were also called to the scene. When the first unit arrived at the scene, the fire was intense and extensive, involving a large portion of the building and extending through the roof on the rear east side.

Hose lines were laid from nearby hydrants, pumpers and aerials were set up and the fire attack and other procedures were initiated to extinguish the fire. Fire fighting personnel were aware that chemicals were present on site, but a complete list of chemicals, and their quantity, was not immediately available. Due to the full involvement of the fire, it could not be readily determined to what extent any of these chemicals might be involved in the fire, nor was their exact location or the state of the manufacturing processes known.

Hazardous materials manuals were checked for a guide to procedures and necessary precautions. According to the Department's report, extra precautions were taken at this time to allow for a worst-case scenario.

As the fire diminished, additional evaluation was possible. With the assistance of the Plant Manager, it was possible to determine which chemicals were at the plant site. The list included:

12 drums of phenolsulfonic acid;

30 drums of phenol resins;

7 drums of Surfactant (containing isopropanol, sodium salts, and organic esters);

4 drums of Freon 11;

120 cases of paint in spray cans;

Large amounts of dextrose (2 tons in bags);

Very small amounts of pesticides.

The phenolsulfonic acid and phenol resins were stored in a separate storage area separated from the fire. The dextrose, although water damaged, was, for the most part, not involved in the fire. The pesticides and aerosol leaf gloss and dyes were in the office area storage room and were not involved in the fire. The aerosol paint cans on the fringe of the fire were exploding from the heat in a rather spectacular fashion, but were extinguished when the hose lines reached them.

The materials that were involved in the fire were as follows:

A couple of drums of Freon 11;

Less than 1 drum of phenolsulfonic acid, which had been hooked up to a mixer;

Seven drums of surfactant, an alcohol type wetting agent;

The remaining substance involved in the fire, other than the building materials themselves, was a large amount of the finished product, a wet and dry foam called Oasis.

The fire was brought under control about 4 hours after it was reported. Overhaul and salvage operations continued to about 23:00 hours on March 6, 1987. Following the fire the trucks were washed down and fire fighting gear and clothing were also washed. Any person taken to the hospital was "released with negative symptoms, as was one test case firefighter, after a full examination".

Study Goals and Design

International experience with the effects of cancer causing agents (carcinogens) has indicated that there is usually an interval of 10 years or more between exposure to a carcinogen and death from cancer. This pattern suggested that the time since attendance at the HT fire might be too brief to account for the cancer experience of the men at the fire, and that this fire might simply have been an event which drew attention to the result of exposures to combustion products occurring earlier in the men's careers.

The goals of the study were thus to: 1) examine the mortality experience of the firefighters over as long a time frame as possible in order to look for an association between a career as a firefighter and an increased risk of cancer; 2) compare the firefighters' cancer experience in the period after the HT fire with their cancer experience before the HT fire; 3) compare the cancer rates of those in attendance at the HT fire with the cancer rates of those not in attendance; and, 4) search for any associations between activities at the fire scene and the risk of developing cancer.

The study was accordingly designed to include men who had been on the rosters of the fire and police Departments as far back as the available records would allow us to determine. It would thus be possible to examine any associations between firefighting and police careers and the risk of cancer and we would be able to compare cancer rates in the period after the HT fire with those in the period preceding it. The inclusion of police officers would allow the experience of the firefighters to be compared with that of a group of men who resided in a similar region of the Province and who had also passed a test of physical fitness at the time of hire.

Many of the men present at the HT fire had completed an exposure report for the Fire Fighters Association. These reports were used in an attempt to identify any fire-related factors which might be associated with the development of cancer following the fire.

Study Population

A roll of firefighters was compiled by Mr. Peter McGough, Secretary of the Kitchener Professional Firefighters Association. His database was compiled from City of Kitchener records and old Departmental reports. The city records were complete from the mid 1970s. The completeness of the old reports was uncertain. A roll of Waterloo Regional police officers was provided by the Human Resources Department of the Waterloo Regional Police Force. The roll consisted of all officers on the staff of the Department on or after the amalgamation of the local forces on January 1, 1973.

There were 275 men on the fire department roll, of whom 179 were current employees, and 96 were no longer members of the force. Six firefighters had to be removed from the analysis because of incomplete information. Four men were said to be dead, but no date of death was available for them and their death certificates could not be located at the Ontario Death Registry or at Statistics Canada. For 2 additional former firefighters, the date at start of employment could not be ascertained. All 6 of these men had left before 1973. After the deletions, there were 269 men in the firefighters population. No women on the fire department roster had been active firefighters.

There were 759 employees on the Police Department roll, including 53 females. Because of their small number and relatively recent employment, the women were excluded from the statistical analysis. There were thus 706 men on the Police Department roll, of whom 465 were current employees, and 241 were no longer members of the force.

Two men had been members of both departments. One had joined the police department in 1979, and moved to the fire department in 1989. The second had joined the police department in 1983 and moved to the fire department in 1990. (In the statistical analysis, person-years of observation for these 2 men were assigned to both Departments in the appropriate Time-since-hire categories.)

Details of the study population are given in Table 1.

Follow-up and Determination of Vital Status

Several methods were used to determine the vital status of members of the study population. The Departments reported which men on the roster were currently active, which of their pensioners were alive, and identified some former employees as being deceased. The entire roll was sent to the Ontario Cancer Registry and 3 former employees were identified as deceased. A list of 64 names of men of unknown status was sent to the Ontario Ministry of Transport, and 39 men were identified as having had a transaction with the Driver Licence Registry within the last 3 years. They were withdrawn from the statistical analysis with vital status "Alive" on the date of their last transaction with the Ministry of Transport. The residual list of names was sent to Statistics Canada for tracing at the Canadian Mortality Database, and 3 deaths were identified. The remaining 25 men with undocumented vital status were presumed to be alive on December 31, 1987, the latest date at which the Canadian Mortality Database was complete, and were withdrawn from the statistical analysis with vital status "Alive" on that date. In the statistical analyses, the officially coded cause of death on the death certificate was used to classify the deaths by cause.

Table 2 provides details of the tracing methods and vital status of the men on force on or after January 1, 1973.

Methods of Statistical Analysis

There were several goals for the statistical analysis. The first aim was to compare the mortality patterns of the firefighters and police officers to that of the general population of Ontario. We also wished to compare the mortality pattern of the firefighters with that of the police officers and mortality in the time period after the HT fire with that occurring during the period of time before the HT fire.

1) Comparison with the Ontario Population

Each man was followed from his date of hire or January 1, 1973, whichever came later.

Follow-up ended on the date of death, the date a man was withdrawn "Alive" as a result of the Driver Licence or Mortality Database searches, or December 31, 1990 for those men still living. Each year of follow-up was categorized by age and date (in 5-year intervals), and length of time since hire. The "PERSON YEARS"[1] computer program was used to compare mortality rates in each of the age-date-years since hire blocks with the corresponding Ontario male mortality rates, and to sum the mortality rates over blocks to produce an "EXPECTED" mortality pattern.

Preliminary analysis indicated that the mortality rates for firefighters who had left the department before the 1970s appeared to be substantially higher than those of men on the force during the 1970s or later. It was suspected that this was an artefact due to the manner in which these men had been identified, which was primarily from old Departmental publications. It is hypothesized that names were more likely to appear in these publications when men died, so that men were more likely to be added to the study roll if they died rather than if they remained alive. To overcome this methodologic bias, men leaving before 1973 were removed from the main analysis, and a discussion of their mortality pattern will be presented separately later. **The main analysis is thus restricted to firefighters and police officers employed on or after January 1, 1973.**

2) Comparisons of the Experience of the Firefighters and Police Officers

Point and interval estimates of the relative risk of death for firefighters compared to police officers were computed by the exact methods described in Breslow and Day[2]. This method was also used to compute the relative risks of those present at the HT fire compared to the men not present at the HT fire.

3) Association Between Firefighting Activities at the HT Fire and Death From Cancer

Many of the men present at the HT fire had completed an exposure report for the Fire Fighters Association. These reports were used in "case-control" analyses to attempt to identify

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[1] Coleman M, Douglas A, Hermon C, Peto J. Cohort Study Analysis with a Fortran Computer Program. Int J Epidemiol 1986;15:134-137.

[2] Breslow NE, Day NE. Statistical Methods in Cancer Research. Volume 2. Pages 93-95. IARC Scientific Publication Number 82. 1987.

any fire-related factors which might be associated with the development of cancer following the fire. The EGRET computer program[3] was used to compute Relative Risks (Odds Ratios) and exact 95% Confidence Limits from the 2x2 tables.

Results

Table 3 shows the distribution of Person-Years of follow-up for the 2 Departments. It can be seen that over the course of follow-up the men were generally quite young, and that the police officers were younger than the firefighters.

1) Comparisons of mortality of firefighters and police officers with the Ontario average: January 1, 1973 to December 31, 1990

Table 4 shows the results of the comparisons of the mortality of the firefighters and police officers with the Ontario average during the time period January 1, 1973 to December 31, 1990. *This time frame includes the periods both **before and after** the HT fire.* The causes of death are classified as: All Causes combined; All Malignancies combined; subgroups of malignancies including all Digestive Cancers, Respiratory Cancer, and Brain Cancer; all Circulatory Diseases; Ischemic Heart Disease (heart attacks); Respiratory Disease; and Violent Causes including work-related and non work-related accidents. Table 4 shows the number of deaths that occurred (Observed) and the number that would be expected to occur in an average group of Ontario men of the same number and age distribution (Expected). The ratio Observed/Expected will thus be greater than 1.0 if the death rate has been higher than the Ontario average and will be less than 1.0 if the death rate has been lower than the Ontario average.

During the period of observation, overall mortality rates among officers in both Departments *were substantially less than the Ontario average.* This is a common observation

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[3] EGRET Statistical Software. Statistics and Epidemiology Research Corporation. Seattle, 1990.

among working populations where applicants must pass a test of physical fitness in order to be hired. Mortality rates from cancer were close to the Provincial average. Among firefighters, mortality from circulatory and respiratory diseases was substantially below the Provincial averages. Among police officers mortality rates from circulatory disease were close to the Provincial average; low mortality in the period up to 30 years from hire was offset by above average mortality in the period 30 or more years after hire. Deaths from violent causes were less than the Provincial average in both Departments. Three firefighters died from violent causes; one man was killed in the line of duty, one was killed in an off-duty motor vehicle accident, and one was killed in an airplane crash. Three police officers died from violent causes; none was killed while on duty.

When examining the results in these mortality tables, one must bear in mind the role played by random fluctuations. It is known that rates of death fluctuate about an average. Suppose, for example, that the average death rate among 60 year old men was 5 deaths per 100 men per year. Then, if we observed random groups of 100 men in 5 consecutive years, we might find 3, 7, 5, 6, and 4 deaths in each of these years, respectively. Since random fluctuation is a fact of life, statistical methods have been developed to assess whether any observed number, such as 7 in the example above, is far enough away from the average number that one might conclude that the rate in the group under observation is truly different from average. These methods involve calculation of the "Statistical Significance" and "95% Confidence Limits". We say that a difference is statistically significant at the 5% level if there is only a 5% chance that a difference as large as the one observed would occur as the result of a chance fluctuation. The 95% Confidence Limits are a statistical statement, derived from one observation, of what the average is likely to be. For example, if 7 deaths were observed during one year, it might be calculated that there is a 95% probability that the average death rate is between 3 and 14 deaths per year.

In the particular case of the firefighters and police officers, none of the differences between the observed deaths and the Provincial averages in the "TOTAL" column of Table 4 were statistically significant, that is, they are compatible with chance fluctuations about the Provincial average in these relatively small groups of men.

Figure 1 shows the mortality pattern in graphic form.

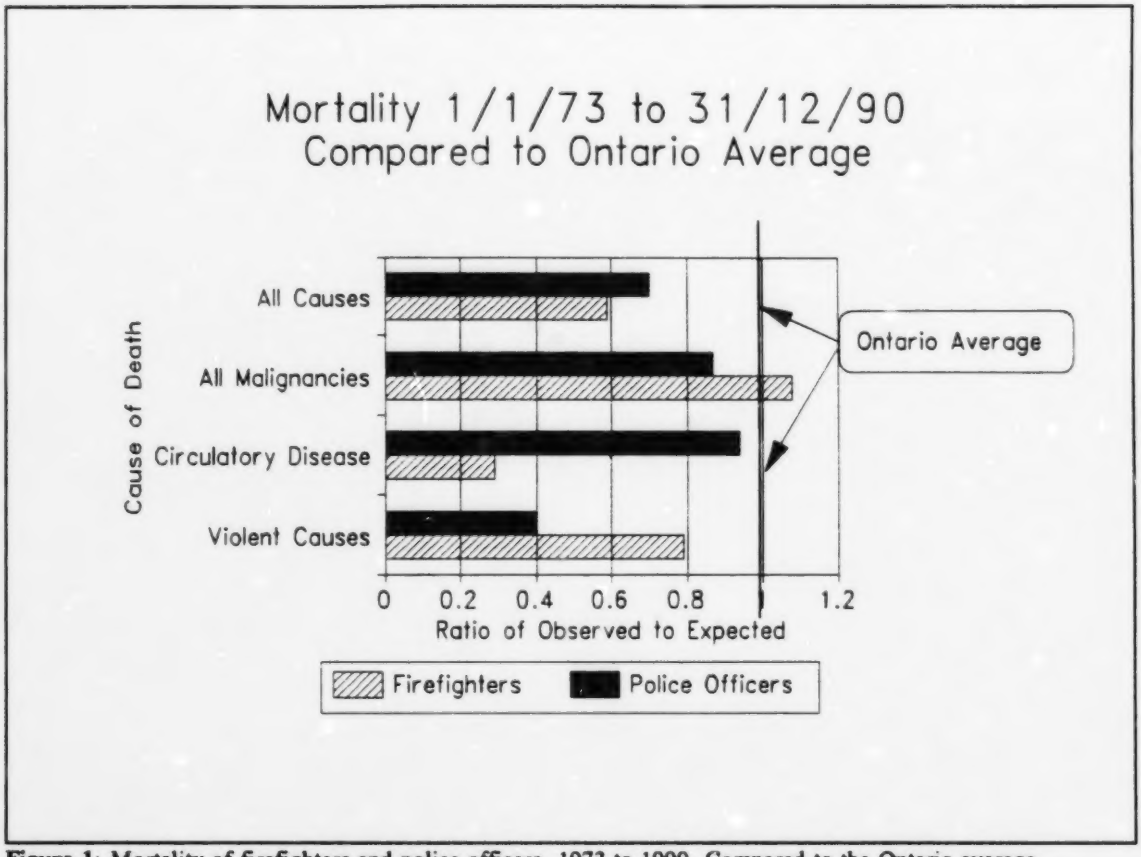

Figure 1: Mortality of firefighters and police officers, 1973 to 1990, Compared to the Ontario average.

It was observed that 2 police officers died from brain cancer, a rate about 5 times higher than the Ontario average. There has recently been some concern that radar emissions might be associated with an increased risk of brain cancer, and this possibility was investigated here. Each man who died of brain cancer was randomly matched with 5 other officers who were born in the same year and who were alive at the time of death of the brain cancer victim. The list of 12 names was sent to Staff Sergeant Calma of the Police Department and to Ted Thornley of the Officers Association for assessment of potential exposure to radar units. It was determined that *none* of the 12 officers had worked with radar units. It is thus concluded that exposure to radar emissions was not a factor in these brain cancer deaths.

2) Comparison of the Mortality of Firefighters with the Mortality of Police Officers

The results presented so far have compared each of the Departments separately with the

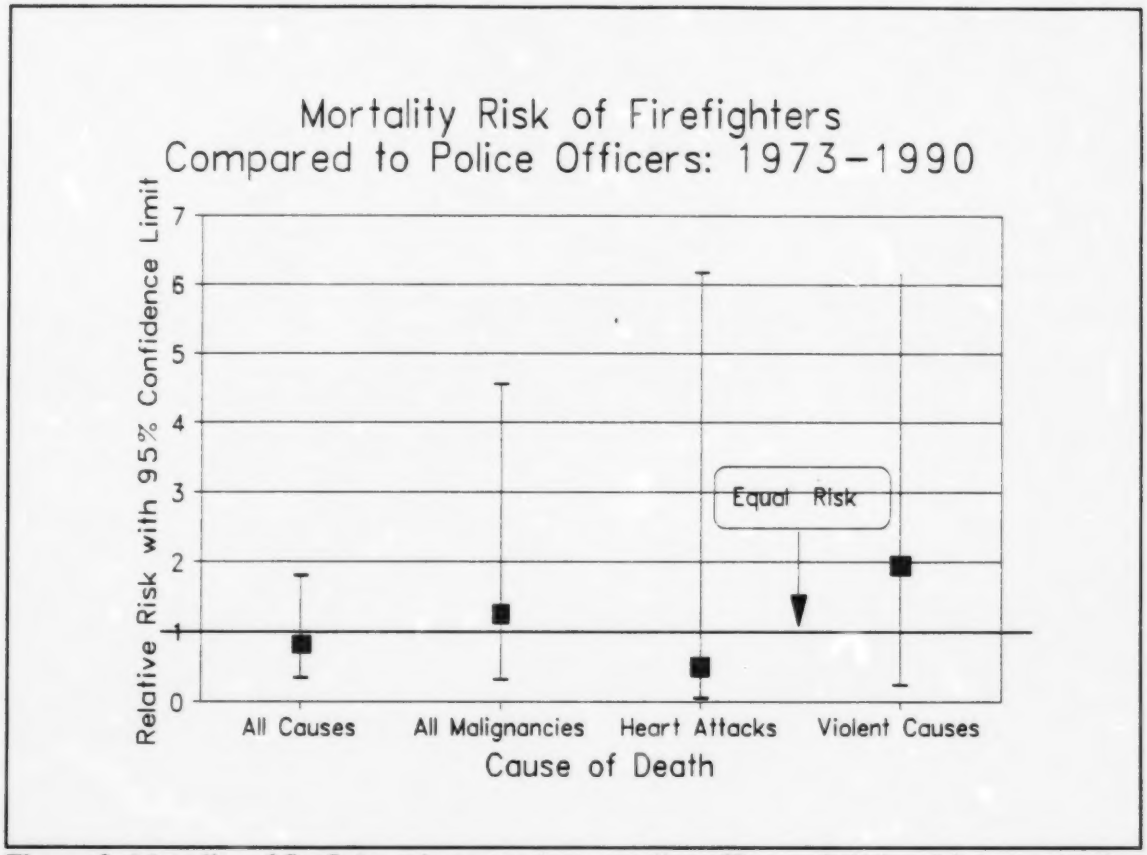

Figure 2: Mortality of firefighters in comparison to police officers. Relative risk is greater than 1.0 if mortality rates were higher among firefighters.

Provincial average. Table 5 and Figure 2 compare the mortality of the firefighters with that of the police officers. Over the time period 1973 to 1990 the firefighters had a lower mortality rate, but none of the differences are statistically significant. It will be noted that the confidence intervals on the comparative risk are very wide. This is due to the fact that one is comparing 2 mortality ratios based upon quite small numbers of deaths. As a result, the role of chance fluctuations is potentially quite great.

3) Mortality January 1, 1973 to December 31, 1990 in Relation to Length of Employment

One might expect that if exposure to toxic substances during firefighting operations increased the risk of cancer, the risk might depend upon the amount of the exposure. In the absence of quantitative information about the extent of exposure to any toxic substances during a career, length of employment has been used as a surrogate for amount of exposure. The men were divided among 2 groups, those employed less than 10 years and those employed 10 years or more. Table 6 shows mortality, 20 or more years after hire, according to length of employment. Because few men left employment before 10 years there were very few person-years of observation after 20 years in the shorter employment group. The mortality results for the men with 10 or more years employment are similar to the data presented in Table 4 for the whole workforce.

4) Mortality among Firefighters Who Left Before 1973

It was noted above that the mortality pattern among firefighters who left before 1973 appeared to be different than the pattern among men on staff during 1973 or later. Table 7 illustrates this observation by comparing each of these 2 groups of men with the Ontario average. Mortality among the men who left before 1973 was substantially higher, primarily due to increased mortality from circulatory disease. As mentioned previously, it is suspected that this is an artefact due to the manner in which these early retirees were identified for the study cohort.

These men might be included in a statistical analysis if one presumes that their chance of inclusion on the study roll is unrelated to the *cause of death*, even though it seems likely that it is related to the *fact of death*. With this assumption, it is possible to carry out a **Proportional Mortality Analysis** in which only the distribution of causes of death is compared to the pattern among the general population of Ontario. The results of this Proportional Mortality Analysis for all 36 deaths occurring among the firefighters from 1956 to the end of 1990 are presented in Table 8. It can be seen that the pattern of causes of death among the Kitchener firefighters is very similar to the Ontario average.

5) Mortality in Relation to the HT Fire

The analysis so far has ignored the HT fire and has examined mortality during the entire period from January 1, 1973 to December 31, 1990. We now look at mortality rates up to the time of the fire on March 6, 1987 and mortality rates from the time of the fire on March 6, 1987 to December 31, 1990 among those on staff in 1973 or later.

a) Mortality up to the Time of the HT Fire

Table 9 compares the mortality of firefighters and police officers to the Provincial average for the time period January 1, 1973 to March 6, 1987. Once again, the mortality rates are less than average.

b) Mortality after the HT Fire

Table 10 compares the mortality of firefighters and police officers to the Provincial average for the time period March 6, 1987 to December 31, 1990. Mortality among the men present at the HT fire was higher than the Provincial average because of the cancer deaths which initiated this investigation. All 4 of the deaths among the men at the fire were from cancer. Three cancer deaths occurred among the firefighters present at the fire, a rate 10 times higher than the Ontario average. The probability of observing 3 or more deaths, *in a randomly selected group of men,* when 0.30 are expected is 4 chances per 1000. One police officer died of cancer, once again a rate substantially higher than the Ontario average. Among men not present at the HT fire, mortality continued to be less than the Provincial average.

The data are illustrated in Figure 3.

Table 11 compares the mortality rates among firefighters present at the HT fire with: 1) rates among Kitchener firefighters in the 14 years prior to the HT fire; and 2) rates among firefighters (including retirees) not present at the HT fire. Also presented in the Table is a comparison of mortality rates for firefighters *not present at the HT fire* with rates among Kitchener firefighters in the 14 years prior to the HT fire. For men present at the HT fire, the rates after the fire were substantially higher than those in the period before the fire, while for firefighters, including retirees, not present at the HT fire, mortality rates were similar to those in the period before the fire. In examining this table it must be remembered that, from a

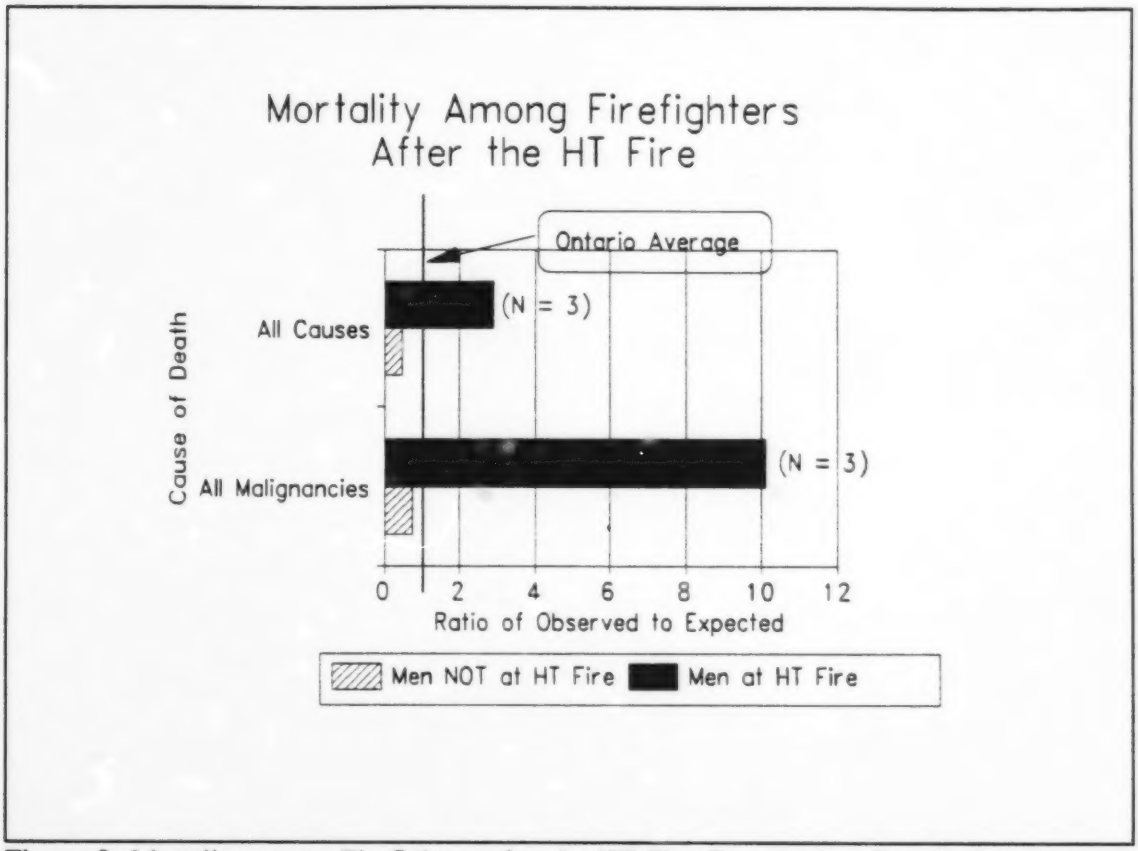

Figure 3: Mortality among Firefighters after the HT Fire Compared to Ontario Average.

statistical point of view, we are comparing rates based upon very small numbers of deaths. As a result, the role of chance fluctuations is greatly magnified, as expressed by the extremely wide confidence limits for the Relative Risk. Thus although the risk of cancer death among firefighters at the HT fire was 29.8 times higher in the years after the fire than in the 14 years before the HT fire, the 95% Confidence Limits on the risk range from 0.36 to 1564.

6) The Cancer Deaths

The 3 cancer deaths among the firefighters illustrate the difficulty that physicians often have in determining the type of cancer from which a patient suffers. In none of the 3 cases was the identification of the tumour type made prior to death, and for 2 of the men uncertainty about

the correct classification persists. For 1 man, the death certificate listed testicular cancer as the cause of death. A postmortem examination was performed, and the pathologist found normal testes and a widespread, poorly differentiated carcinoma of unknown primary. Specimens were sent to the Canadian Tumour Reference Centre for review. Three panellists agreed that the tumour was a poorly differentiated carcinoma of unknown primary. Three other panellists expressed the opinion that the tumour morphology was consistent with a primary hepatocellular (liver) cancer.

Physicians were unable to classify a second man's tumour prior to his death. The death certificate listed metastatic carcinoma of unknown primary as the cause of death, and postmortem examination was not performed.

In the third case, the death certificate listed carcinoma of the bile duct as the cause of death. Postmortem examination determined the cause of death to be primary carcinoma of the liver.

The cause of death of the police officer was different from any of the above (and is not discussed here for reasons of privacy).

7) Association Between Firefighting Activities at the HT Fire and Death From Cancer (Case-Control Analysis)

Firefighters and police officers present at the HT fire had a higher risk of developing cancer than men not present at the HT fire. We also note that while 3 of the 71 firefighters in attendance at the fire developed cancer, 68 of the 71 men did not. This latter point raises the question as to whether, compared to the men at the fire who did not develop cancer, there was anything different about the activities or exposures of the men who developed cancer. If any differences could be found, they might provide information about the fire-relatedness of the tumours.

Many of the men attending the fire subsequently completed an "Exposure Report Form" which had been designed by the Health and Safety Committee of the Kitchener Profession Fire Fighters Association (an example is attached in the Appendix to this report). This form contained questions about activities at the fire scene, smoke conditions, symptoms such as cough and rash

experienced at the scene or later, special equipment and decontamination procedures, co-workers at the time of exposure, and personal habits such as cigarette smoking. Copies of the Exposure Report Forms were provided by the Secretary of the Fire Fighters Association.

Fifty six (including 2 cancer victims) of the 71 men who had been at the fire completed reports. Since respondents indicated with whom they had been working it was possible to infer activities for an additional 12 men (including 1 cancer victim) by assuming that they had performed the same duties as the men they had worked with closely. Data was thus available for 68 of the 71 men for fire-related questions, but was available for only 56 of the 71 for personal questions, such as symptoms experienced after the fire.

Variables examined in the case-control analysis included *Stage of Fire during attendance* (Early Stage, Free Burning, Smouldering), *Activity During Attendance* (Extinguishment, Light Overhaul, Heavy Overhaul), *Physical symptoms* (burning eyes, cough, nose/lung irritation, nausea, dizziness, headache, skin irritation, or other), visit to a physician, and smoking habit. Each man may have contributed to multiple analyses; a firefighter who, for example, reported that he was present at both the freeburning and smouldering stages of the fire was counted as being "exposed" to both stages.

Table 12 presents the results of the analysis of cancer risk by Stage of the Fire. None of the cancer victims reported that they were present at the early stage, 1 reported that he was present at the freeburning stage, while 2 reported that they were present at the smouldering stage. In none of these instances was the risk *among those present during any of these stages* substantially different from the cancer risk among those not present.

Table 13 presents a similar analysis for fire fighting activity at the fire. One of the 3 cancer victims was present during extinguishment, and all 3 were involved in overhaul operations, 1 in light overhaul and 2 in heavy overhaul. The risk of cancer was 4-fold higher among men involved in heavy overhaul operations (2 cases among 22 men) than among men not performing heavy overhaul (1 case among 46 men), but the number of victims is so small that this difference is compatible with coincidence. Men performing overhaul operations are potentially exposed to fumes from smouldering debris. Presence at a smouldering stage was inconsistently reported by men who reported performing overhaul operations. If we group together men who performed any overhaul operations, we find that 3 of 38 men who were

involved in overhaul operations developed cancer, while none of the 30 men who were not involved in overhaul operations died from cancer. The probability of a difference this large happening by coincidence is 16% (exact 1-tailed P = 0.1683).

Table 14 indicates that men who reported irritative symptoms such as burning eyes, cough, or nose/lung irritation had a higher risk of developing cancer than men who did not report these symptoms. A number of men *who did not develop cancer* reported other symptoms that the cancer victims did not report. These included nausea, dizziness, and headache, and skin irritation.

Table 15 reports the associations between cigarette smoking, physician visits, and cancer death. Only 1 man is reported to have visited a physician after the fire, and this man died of cancer.

Since there was (fortunately) only 1 death among a police officer in attendance at the fire, it was not meaningful to attempt an analysis of the activities of the police officers.

a) Discussion of Case-Control Findings

Assessment of any differences in exposures or activities at the HT fire between those men who developed cancer and those who did not is severely hampered by the small size (from a statistical viewpoint) of the crew at the HT fire. *Although some differences emerge from the analysis, coincidence is always a viable explanation because changing the "exposure status" of only one cancer victim would cause the differences to disappear.* Using Heavy Overhaul activity as an example, we found that 2 of 22 men engaged in this activity developed cancer compared to 1 of 46 men who were not involved with Heavy Overhaul; this translates to a 4-fold higher risk of cancer among men involved with this activity. If, however, we experimentally change the status of one of the cancer victims so that now only 1 of 21 men who were engaged in Heavy Overhaul developed cancer compared now to 2 of 47 who did not, there is no longer any difference between these 2 groups. *Chance is thus a plausible explanation for these differences, **although not necessarily the correct explanation.***

One might presume that men involved with overhaul operations had a higher exposure to products of combustion than men not engaged in these operations because smouldering debris continues to give off fumes and because firefighters often do not wear respiratory protection

during this phase of the firefighting operation. As noted above, 3 of 38 men who were involved in overhaul operations developed cancer, while none of the 30 men who were not involved in overhaul operations died from cancer. The probability of a difference this large happening by coincidence is 16% (exact 1-tailed P = 0.1683).

It was also found that men who reported irritative symptoms such as burning eyes, cough, and nose/lung irritation were more likely to develop cancer than men who did not report these symptoms. These symptoms are consistent with substantial exposure to combustion fumes, but once again the differences are compatible with coincidence. It should also be noted that while some men reported other potentially exposure-related symptoms such as nausea, dizziness, headache, and skin irritation, none of the cancer victims reported these symptoms.

Chemicals in the Fire

A major concern of the men at the fire was exposure to the chemicals stored at the HT plant. Shortly after the fire an inventory of chemicals was compiled and Material Safety Data Sheets for the products in use were obtained from the Company. Table 16 provides a list of the chemicals abstracted from the Material Safety Data Sheets. It would appear that only a very few of these chemicals were involved in the blaze.

The Fire Department determined that much of the chemical inventory was in storage locations where it was not damaged by the blaze. It was concluded that the materials that were involved in the fire were as follows:

- A couple of drums of Freon 11;
- Less than 1 drum of phenolsulfonic acid, which had been hooked up to a mixer;
- Seven drums of surfactant, an alcohol type wetting agent;
- The remaining substance involved in the fire, other than the building materials themselves, was a large amount of the finished product, a wet and dry foam called Oasis. "It's toxicity is the equivalent of red oak wood" (Fire Department report).

Assessment of the hazard posed to firefighters by these compounds is difficult because there is no measure of exposure of the officers to any of these compounds or to their thermal decomposition or combustion products, some of which may be substantially more toxic than the original compounds. For example, Freon 11 is used as a foaming agent in the manufacture of foams. It has very low toxicity, and has been used as a propellant in canisters of asthma medication. In contact with flame, however, it may be converted to phosgene gas, a severe respiratory irritant, which can lead to death by respiratory failure. Freon 11 has been tested for carcinogenicity in rats and mice, and has been negative in both species.

Phenolsulfonic acid is used in the manufacture of foams. Its boiling point is 212 °F, so that it is likely to have vaporized in the fire. There is little information about its toxicology. Poisonous vapours are produced in fire, and its decomposition products include phenol vapours, oxides of sulphur, as well as carbon monoxide and carbon dioxide. Phenol is a potent irritant, but is not a recognized carcinogen. Sulphur oxides are also respiratory irritants, but are not recognized carcinogens.

According to the Material Safety Data Sheets, the surfactant mixture contained mixtures of sodium salts of organic acids plus organic esters, in additional to isopropyl alcohol (rubbing alcohol). The boiling point is 180 °F. Oxides of sulphur, as well as carbon monoxide and carbon dioxide may be present in the combustion products. Organic esters are not recognized as carcinogenic substances.

The decomposition products of the Oasis foam may include phenol, formaldehyde, acrolein, and carbon monoxide. Formaldehyde is capable of inducing nasal cancers in experimental animals and is a suspect carcinogen of the human respiratory tract. Acrolein may cause severe irritation of the eyes and lungs. It is not a recognized human carcinogen.

Discussion

This investigation was carried out because of concerns about cancer occurring among firefighters and police officers in attendance at the Horticultural Technologies fire on March 6, 1987. The general impression that cancer rates among men present at the fire were higher than rates in the Departments before the fire has been confirmed by the formal analysis presented here. Important factors to be considered in interpreting the results are the brief interval between the fire and onset of disease, the unknown exposures occurring during firefighting operations, and the small number (from a statistical viewpoint) of men involved.

The concept of latency, the length of time between exposure to a toxic agent and death from cancer, is important when considering causes of cancer. Past experience has shown that cancers of the blood may appear relatively quickly after exposure, often in less than 5 years. Cancers of the solid organs, such as the liver, have a different behaviour and generally 10 or more years passes before death occurs. A prominent example of this is liver cancer caused by exposure to the chemical vinyl chloride, used in the manufacture of plastics. An English study[4] of workers employed in the vinyl chloride industry for 1 year or more identified 7 deaths from liver cancer among the most heavily exposed men. The time from first exposure to death ranged from 8 to 33 years, with a median of 25 years. All of the men had been exposed to the chemical for 2 years or more. Another study of workers at a chemical plant in Quebec[5] found 9 deaths from liver cancer, with latency ranging from 11 to 26 years and a minimum length of exposure of 5 years (it must be noted that all workers in the study had to be employed for at least 5 years, so that any cancer deaths earlier than 5 years from hire would not be included).

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[4] Jones RD et al. A mortality study of vinyl chloride monomer workers employed in the United Kingdom in 1970-1974. Scand J Work Environ Health 1988;14:153-160.

[5] Theriault G and Allard P. Cancer mortality of a group of Canadian workers exposed to vinyl chloride monomer. J Occup Med 1981;23:671-676.

There are 3 plausible explanations for the cancer deaths among the men at the HT fire which should be considered here:

1) These deaths were related to occupational exposures occurring prior to the HT fire, which served only to draw attention to cancer risk among firefighters;

2) These deaths were caused or accelerated by exposures received at the HT fire;

3) These deaths were unrelated to occupational exposures and their apparent relation to the HT fire is coincidental.

1) Causation by Earlier Exposures

The unusually short interval between the HT fire and death from cancer, as well as the brevity of the exposure there, suggests that perhaps earlier exposures incurred over a firefighting career might have been responsible for these deaths. It is known that firefighters may be exposed to toxic chemicals in the course of fighting ordinary house fires. For example, in a study[6] in Buffalo, New York it was found that firefighters were frequently exposed to chemicals including carbon monoxide, benzene, sulphur dioxide, hydrogen cyanide, aldehydes, hydrogen chloride, and dichlorofluoromethane as well as to particulates. Furthermore, in many cases of the heaviest exposure to these materials respiratory protective equipment was not used because of the visual impression of low smoke intensity.

The study design utilized here permitted consideration of the possibility that firefighters have a higher risk of cancer than police officers and other members of the population. The data in Table 4 compared cancer risk among firefighters and police officers to the Ontario average during the time period 1973 to 1990 and Table 5 compared the firefighters to the police officers. The results in these Tables indicate that from January 1,1973 to December 31, 1990 Kitchener firefighters had a cancer risk that was equal to the Ontario average and that there was essentially no difference between the cancer risk of firefighters and police officers.

The question whether firefighters are at increased risk of cancer has attracted much scientific attention in recent years. Table 17 shows the results of cancer studies in 8 other

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[6] Brandt-Rauf, PW et al. Health hazards of fire fighters: exposure assessment. Br J Ind Med 1988;45:606-612.

jurisdictions. Some of the studies found risks slightly higher than average, while others found risks slightly lower than average. Combining the results of all of them we find that firefighters have had the same risk of death from cancer as the general population of their jurisdictions. The Kitchener firefighters, overall, have had an experience consistent with this pattern. *It is thus concluded that the cancers occurring after the HT fire are not likely attributable to exposures occurring earlier in the firefighters' careers.*

2) The HT Fire as a Causative Factor

As discussed above, during the period 1973-1990 firefighters and police officers had a cancer mortality risk similar to the Ontario average. Nevertheless, the risk was lower than average before the fire and it remained lower than average for those men who were not present, while the cancer risk was higher than average in the years after the fire for those men who were present. This pattern is compatible with the effect of HT fire-related exposures, but is not proof that these exposures were the cause of the deaths. We found that men involved in overhaul operations at the fire had a higher risk of cancer than men not so involved, and that men who reported certain irritative symptoms had a higher risk of cancer, but the number of cancer deaths was small and these differences are compatible with chance. The major arguments against there being a causal connection are the short latency and the probability that chemical exposures, although unmeasured, were low in comparison to those which occurred in industrial settings where it commonly took years of exposure before cancer risk was measurably increased. *We conclude that it is not possible to convincingly confirm or refute the possibility that unmeasured chemical exposures at the HT fire were in some way responsible for the cancer deaths occurring among the men in attendance at the fire.*

3) Coincidence

Cancer mortality rates were substantially higher among exposed firefighters and police officers. This is an unusual occurrence, but is not incompatible with coincidence. It will not be possible to decide for or against coincidence until additional time has passed. Should the cancer rate return to normal in the years to come, then it will become more likely that the occurrence of the cancer deaths among men at the HT fire was a tragic coincidence.

Conclusions

We have found that in the period 1973 to 1990, Kitchener firefighters and Waterloo Regional Police officers have had a better than average mortality experience, that is, their life expectancies have been longer than that of the average man in Ontario. This finding is to be expected, since passing a test of physical fitness is required in order to join the forces. During this same period, cancer mortality rates have been about the same as the Ontario average, and were similar for members of both forces.

The major focus of attention has been the deaths from cancer since the Horticultural Technologies fire in March, 1987. This analysis has confirmed that men in attendance at the fire have had a substantially higher cancer risk than was observed either before the fire or among men who were not in attendance at the HT fire. As was anticipated, we are unable to provide a definitive explanation for the increased cancer rates after the fire. It might seem natural to presume that the deaths were caused by exposure to toxic chemicals at the fire scene, and this explanation cannot be ruled out. We cannot, however, rule out coincidence as an alternative explanation.

Toxic chemicals were present at the fire scene, and it is likely that some were absorbed by inhalation or penetration through skin. There is, however, no way to determine to which chemicals, and in what quantities, any individual was exposed. The quantities were likely to have been small in comparison to historic exposures in the chemical industry. In that industry it usually took many years of exposure to chemicals in order for increased cancer risk to be observed, and a much longer time usually elapsed before cancer deaths occurred.

There are several social consequences connected to the assessment of whether or not these deaths are related to exposures at the HT fire. Firstly, a number of compensation claims have been filed with the Workers' Compensation Board. It is the responsibility of Compensation Board officials to make a determination of compensability in each of these cases, and no additional comment will be made here. Secondly, there is the problem of anxiety among other officers present at the HT fire, and the associated issue of medical surveillance for the early detection of health problems possibly associated with attendance at the fire. Of the several possible explanations for the cancer cluster after the fire, it might prove best for peace of mind to accept coincidence as the best explanation until there is good reason to think otherwise. It

is my opinion that medical screening has not been demonstrated to be of any value in the detection of the types of tumours which have occurred since the fire, and there are very few cancer screening modalities which are of demonstrated value in men. I would thus not, at this time, recommend any special medical surveillance of the men in attendance at the HT fire.

It is proposed that the Ministry of Labour remain in contact with the forces, and that the analysis of the cancer experience be updated in several years time. Should the cancer risk return to its baseline value, this will suggest that coincidence was indeed the correct explanation.

Acknowledgements

The author wishes to thank the members of the Study Steering Committee, John Beacock, Roger Freeborn, James Hancock, Harry Kalau, Peter McGough, Pat Rivett, and Ted Thornley for their assistance and guidance in the course of this ongoing study. Peter McGough undertook the responsibility of co-ordinating the collection of information about the firefighters.

APPENDIX

(FIRE FIGHTERS ASSOCIATION EXPOSURE FORM)

The Kitchener Professional Fire Fighters Association

Health & Safety Committee

EXPOSURE REPORT FORM

1) Last Name _____ 2) First Name _____ 3) Middle Initial K

4) Street Address _____ 5) City _____ 6) Postal Code _____

7) Date of Birth Month _____ Day _____ Year _____ 8) Current Age 46 9) Starting Date _____ 10) Cigarette Smoker? ☐ Past ☐ Current ☒ Never 11) Year Began _____ 12) Year Quit _____ 13) Packs per Day _____

14) Hall No _____ 15) Truck Number _____

16) Incident Date 02 06 1987 (Month Day Year) 17) Alarm Time 0103 (24 hr Clock) 18) Incident No 002955

19) INCIDENT TYPE (Check One Only)

a) ☐ Wildland Fire b) ☐ Residential Fire c) ☒ Industrial Fire d) ☐ Vehicle Fire e) ☐ Commercial Fire

f) ☐ Trash/Dumpster g) ☐ Marine Fire h) ☐ Explosion i) ☐ Rescue ☐ Spill

k) ☐ Other (Describe) _____

20) Type Occupancy (Describe) MANUFACTURING PLANT

LENGTH OF EXPOSURE BY FIRE STAGE/ACTIVITY

FIRE STAGE	< 1 hr	2 hr	2-3 hr	3+ hr
21) ☒ Early Stage				
22) ☒ Free Burning				
23) ☐ Smouldering				
24) ☐ Non-Fire Incident				

ACTIVITY	< 1 hr	2 hr	2-3 hr	3+ hr
25) ☒ Extinguishment				6 HRS
26) ☐ Entry/Ventilation				
27) ☐ Rescue				
28) ☐ Light Overhaul				

ACTIVITY	2 hr	2-3 hr	3+ hr
29) ☐ Heavy Overhaul			
30) ☐ Em Med Support			
31) ☐ Investigation			

SMOKE/CHEMICAL/OTHER EXPOSURE (at fire, spill or rescue scene)

32) Smoke Conditions ☐ Light ☒ Heavy ☐ None (33) Smoke Colour(s) YELLOW - WHITE - BROWN

Chemical(s) Present	Vapour/Gas	Dust	Liquid (spray, mist)	Light Smoke	Combustion Product	Sandy Powder	Comments
34) PHENOL SULPHONIC ACID							
35) PHENOL RESIN							
36) DECISIONS WE GUIDE							
37)							

38) Type of Chemical Exposure a) ☒ Inhaled b) ☐ Ingested c) ☒ Skin Contact d) ☒ Eye Contact

e) ☐ Other _____

39) If medical exposure, name of victim, medical condition exposed to _____

SYMPTOMS

	At Incident	Symptom	After Incident
40)		Eyes Burn	
41)		Cough	X
42)		Cough Blood/Nose Bleed	
43)		Nose/Lung Irritation	

	At Incident	Symptom	After Incident
44)		Nausea/Queasiness	
45)		Dizzy	
46)		Ears Ringing	
47)		Headache	X

	At Incident	Symptom	After Incident
48)		Skin Irritation/Rash	
49)		Unconscious	
50)		Other	

MEDICAL DIAGNOSIS

51) Did you receive medical evaluation or treatment after exposure? ☐ Yes ☒ No

Diagnosis (52) ☐ Smoke Inhalation (53) ☐ Contact Dermatitis (54) ☐ Respiratory Tract Irritation

55) ☐ Other _____ 56) Date _____

Doctor/Treatment Facility _____

SPECIAL EQUIPMENT/DECONTAMINATION

57) Were you supplied with special equipment for this incident? ☐ Yes ☒ No

Describe BREATHING APPARATUS TURNOUT GEAR

58) Were special decontamination procedures followed after the exposure? ☒ Yes ☐ No

Describe WASH DOWN ALL GEAR BEFORE LEAVING DECONTAMINATION SHOWER

CO-WORKER AT TIME OF EXPOSURE

59) Please list names of other firefighters working close to you at time of exposure: _____

60) ADDITIONAL INFORMATION (Your function at incident, unusual circumstances, etc.) _____

_____ SIGNATURE

TABLES

TABLE 1: Description of the Study Population

	FIREFIGHTERS	POLICE OFFICERS
Number on Original Roll	275	759
Exclusions	6 with missing data	53 women
Total in Study Population	269	706
Current Employees	179	465
Former Employees	90	241
On Force on or after 1/1/73	227	706
Attended Horticultural Technologies Fire	71	19

TABLE 2: Follow-up Methods and Vital Status of the Study Population

	FIREFIGHTERS	POLICE OFFICERS
Number on Force on or After January 1, 1973	227	706
Active Employees: Alive as of 31/12/90	179	465
Pensioners: Alive as of 31/12/90	37	169
Traced Through Driver License Registry: Withdrawn "Alive" at Date of Last Transaction	0	32
Deceased: Notified by Department, or Identifed in Files of Ontario Cancer Registry or Canadian Mortality Database	11	23
Vital Status Undocumented: Not Identified in Canadian Mortality Database, Presumed Alive on 31/12/87	0	17

TABLE 3: Distribution of Person Years at Risk for All Men on Staff on January 1, 1973 or Later

YEARS SINCE HIRE	FORCE	AGE RANGE														
		15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	TOTAL
0 - 9	Fire	2	191	663	751	299	29	5	0	0	0	0	0	0	0	1942
	Police	51	884	1674	1006	296	94	20	3	11	10	0	0	0	0	4055
10 - 19	Fire	0	0	2	167	533	632	255	24	4	0	0	0	0	0	1619
	Police	0	0	57	940	1456	757	264	66	16	4	4	1	0	0	3572
20 - 29	Fire	0	0	0	0	0	66	343	383	134	9	0	0	0	0	937
	Police	0	0	0	0	25	363	439	391	175	27	6	0	0	0	1429
30 - 59	Fire	0	0	0	0	0	0	0	16	96	107	38	12	1	0	272
	Police	0	0	0	0	0	0	0	62	192	179	93	29	8	0	567
TOTAL	Fire	2	191	666	919	832	728	604	423	234	116	38	12	1	0	4771
	Police	51	884	1732	1947	1779	1215	725	524	395	222	105	32	8	0	9624

Distribution of Person-Years

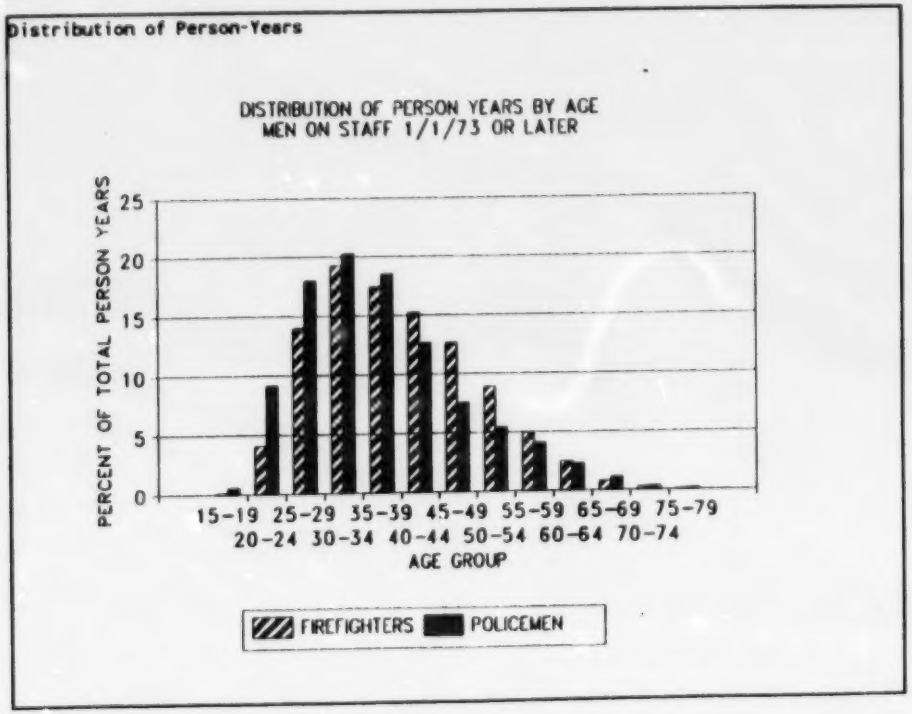

TABLE 4: MORTALITY FOR FIREFIGHTERS AND POLICE OFFICERS COMPARED TO PROVINCIAL AVERAGE
MEN ON STAFF JANUARY 1, 1973 OR LATER FOLLOWED FROM TIME OF HIRE TO DECEMBER 31, 1990

CAUSE OF DEATH	FORCE	YEARS SINCE HIRE														
		0 - 9			10 - 19			20 - 29			30 or More			TOTAL		
		OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E
ALL CAUSES	F	1	2.81	0.36	1	4.38	0.23	6	6.26	0.96	3	5.15	0.58	11	18.6	0.59
	P	2	5.73	0.35	2	7.43	0.27	2	8.63	0.23	17	11.0	1.54	23	32.8	0.70
ALL MALIGNANCIES	F	1	0.33	3.06	0	0.84	0	3	1.78	1.69	1	1.68	0.59	5	4.63	1.08
	P	1	0.70	1.44	0	1.50	0	1	2.39	0.42	5	3.48	1.44	7	8.07	0.87
DIGESTIVE CANCER ICD:150-159	F	0	0.06	0	0	0.24	0	2	0.52	3.85	0	0.49	0	2	1.32	1.52
	P	0	0.14	0	0	0.41	0	0	0.70	0	0	1.03	0	0	2.28	0
RESPIRATORY CANCER ICD:160-165	F	0	0.03	0	0	0.22	0	0	0.68	0	1	0.68	1.47	1	1.62	0.62
	P	0	0.11	0	0	0.38	0	0	0.89	0	1	1.39	0.72	1	2.77	0.36
BRAIN CANCER ICD:1910-1919	F	0	0.04	0	0	0.07	0	0	0.09	0	0	0.05	0	0	0.24	0
	P	0	0.07	0	0	0.12	0	0	0.12	0	2	0.10	20	2	0.41	4.93
CIRCULATORY DISEASE ICD:3900-4599	F	0	0.40	0	0	1.50	0	1	2.67	0.37	1	2.37	0.42	2	6.93	0.29
	P	0	0.76	0	0	2.18	0	1	3.66	0.27	10	5.14	1.95	11	11.7	0.94
ISCHEMIC HEART DISEASE ICD:4100-4149	F	0	0.24	0	0	1.16	0	1	2.12	0.47	1	1.79	0.56	2	5.32	0.38
	P	0	0.48	0	0	1.64	0	0	2.90	0	7	3.87	1.84	7	8.88	0.79
RESPIRATORY DISEASE ICD:4600-5199	F	0	0.07	0	0	0.12	0	0	0.20	0	0	0.28	0	0	0.67	0
	P	0	0.12	0	0	0.19	0	0	0.29	0	0	0.63	0	0	1.23	0
VIOLENT CAUSES ICD:8000-9999	F	0	1.64	0	1	1.23	0.81	2	0.72	2.76	0	0.22	0	3	3.82	0.79
	P	1	3.49	0.29	2	2.39	0.84	0	1.07	0	0	0.48	0	3	7.43	0.40

Notes: OBS = Number of deaths that occurred; EXP = Expected Number of Deaths Based Upon Ontario Average; O/E = Ratio of Observed to Expected
In the TOTAL Column, none of the ratios are significantly different from 1.0 (2-Tailed P > 0.05 for all)

Table 5: Mortality Among Firefighters Compared to Police Officers Men on Staff January 1, 1973 or Later Followed From Time of Hire to December 31, 1990			
Cause of Death	Risk for Firefighters Compared to Police Officers	Lower 95% Confidence Interval	Upper 95% Confidence Interval
All Causes	0.84	0.33	1.81
All Malignancies	1.24	0.30	4.56
Ischemic Heart Disease	0.48	0.05	6.17
Violent Causes	1.95	0.23	14.3

TABLE 6: MORTALITY FOR FIREFIGHTERS AND POLICE OFFICERS 20 or MORE YEARS AFTER HIRE COMPARED TO PROVINCIAL AVERAGE
MEN ON STAFF JANUARY 1, 1973 OR LATER, CLASSIFIED ACCORDING TO LENGTH OF EMPLOYMENT

CAUSE OF DEATH	GROUP	OBS	EXP	O/E
ALL CAUSES	F: < 10	0	0.05	0.
	F: > 10	9	11.36	0.79
	P: < 10	0	0.09	0.
	P: > 10	19	19.59	0.97
ALL MALIGNANCIES	F: < 10	0	0.02	0.
	F: > 10	4	3.44	1.16
	P: < 10	0	0.02	0.
	P: > 10	6	5.85	1.03
RESPIRATORY CANCER ICD:160-165	F: < 10	0	0.01	0.
	F: > 10	1	1.35	0.74
	P: > 10	1	2.17	0.46
CIRCULATORY DISEASE ICD:3900-4599	F: < 10	0	0.02	0.
	F: > 10	2	5.02	0.40
	P: > 10	11	8.77	1.25
ISCHEMIC HEART DISEASE ICD:4100-4149	F: > 10	2	3.90	0.51
	P: > 10	7	6.74	1.04
RESPIRATORY DISEASE ICD:4600-5199	F: > 10	0	0.48	0.
	P: > 10	0	0.92	0.
VIOLENT CAUSES ICD:8000-9999	F: > 10	2	0.94	2.13
	P: > 10	0	1.53	0.

Notes: F: < 10 = Fire Department Employed Less than 10 Years;
F: > 10 = Fire Department Employed More than 10 Years;
P: < 10 = Police Department Employed Less Than 10 Years;
P: > 10 = Police Department Employed More than 10 Years;
OBS = Number of deaths that occurred; EXP = Expected Number of Deaths Based Upon Ontario Average; O/E = Ratio of Observed to Expected

TABLE 7: MORTALITY FOR FIREFIGHTERS COMPARED TO PROVINCIAL AVERAGE
MEN ON STAFF JANUARY 1, 1973 OR LATER and MEN WHO LEFT THE DEPARTMENT BEFORE 1973
FOLLOWED FROM TIME OF HIRE TO DECEMBER 31, 1990

CAUSE OF DEATH	On FORCE	YEARS SINCE HIRE														
		0 - 9			10 - 19			20 - 29			30 or More			TOTAL		
		OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E
ALL CAUSES	> 1973	1	2.81	0.36	1	4.38	0.23	6	6.26	0.96	3	5.15	0.58	11	18.6	0.59
	< 1973	2	0.30	6.72	4	0.89	4.52	2	3.08	0.65	17	11.5	1.48	25	15.8	1.58
ALL MALIGNANCIES	> 1973	1	0.33	3.06	0	0.84	0	3	1.78	1.69	1	1.68	0.59	5	4.63	1.08
	< 1973	1	0.03	33	1	0.16	6	0	0.72	0	2	2.78	0.72	4	3.70	1.08
CIRCULATORY DISEASE ICD:3900-4599	> 1973	0	0.40	0	0	1.50	0	1	2.67	0.37	1	2.37	0.42	2	6.93	0.29
	< 1973	0	0.06	0	1	0.49	2.04	2	1.61	1.24	14	6.24	2.24	17	8.30	2.05

Notes: On Force > 1973 are men on staff 1/1/73 or later; Men on force < 1973 left the Department Before 1/1/73.
OBS = Number of deaths that occurred; EXP = Expected Number of Deaths Based Upon Ontario Average; O/E = Ratio of Observed to Expected

TABLE 8: PROPORTIONAL MORTALITY ANALYSIS of 36 DEATHS OCCURRING AMONG FIREFIGHTERS FROM 1956 to 1990

CAUSE OF DEATH	YEARS SINCE HIRE														
	0 - 9			10 - 19			20 - 29			30 or More			TOTAL		
	OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E
ALL MALIGNANCIES	2	0.42	4.72	1	0.78	1.29	3	2.03	1.48	3	4.90	0.61	9	8.12	1.11
DIGESTIVE CANCER ICD:150-159	0	0.10	0	0	0.21	0	2	0.61	3.26	1	1.57	0.64	3	2.49	1.20
RESPIRATORY CANCER ICD:160-165	1	0.07	14.1	0	0.17	0	0	0.68	0	1	1.70	1.70	2	2.62	0.76
CIRCULATORY DISEASE ICD:3900-4599	0	0.75	0	1	1.58	0.63	3	3.35	0.90	15	10.8	1.39	19	16.5	1.15
ISCHEMIC HEART DISEASE ICD:4100-4149	0	0.54	0	0	1.19	0	3	2.66	1.13	11	7.75	1.42	14	12.1	1.15
RESPIRATORY DISEASE ICD:4600-5199	0	0.08	0	0	0.14	0	0	0.26	0	1	1.58	0.63	1	2.06	0.48
VIOLENT CAUSES ICD:8000-9999	1	1.32	0.76	3	1.72	1.74	2	1.21	1.66	0	0.70	0	6	4.95	1.21

Notes: OBS = Number of deaths that occurred; EXP = Expected Number of Deaths Based Upon Ontario Average; O/E = Ratio of Observed to Expected

TABLE 9: MORTALITY FOR FIREFIGHTERS AND POLICE OFFICERS COMPARED TO PROVINCIAL AVERAGE
MEN ON STAFF JANUARY 1, 1973 OR LATER FOLLOWED FROM TIME OF HIRE TO DATE OF FIRE ON MARCH 6, 1987

CAUSE OF DEATH	FORCE	YEARS SINCE HIRE														
		0 - 9			10 - 19			20 - 29			30 or More			TOTAL		
		OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E
ALL CAUSES	F	0	2.66	0	1	3.91	0.26	3	4.26	0.70	2	2.46	0.81	6	13.3	0.45
	P	2	5.06	0.40	2	5.06	0.40	1	6.11	0.16	10	6.04	1.66	15	22.3	0.67
ALL MALIGNANCIES	F	0	0.31	0	0	0.74	0	1	1.15	0.87	0	0.79	0	1	2.98	0.34
	P	1	0.62	1.61	0	0.97	0	0	1.65	0	3	1.87	1.60	4	5.11	0.78
DIGESTIVE CANCER ICD:150-159	F	0	0.06	0	0	0.21	0	1	0.34	2.97	0	0.23	0	1	0.84	1.19
	P	0	0.13	0	0	0.26	0	0	0.48	0	0	0.56	0	0	1.43	0
RESPIRATORY CANCER ICD:160-165	F	0	0.03	0	0	0.18	0	0	0.41	0	0	0.30	0	0	0.92	0
	P	0	0.09	0	0	0.22	0	0	0.58	0	1	0.71	1.40	1	1.61	0.62
CIRCULATORY DISEASE ICD:3900-4599	F	0	0.38	0	0	1.36	0	1	1.86	0.54	1	1.14	0.88	2	4.75	0.42
	P	0	0.70	0	0	1.46	0	1	2.67	0.37	6	2.85	2.11	7	7.68	0.91
ISCHEMIC HEART DISEASE ICD:4100-4149	F	0	0.23	0	0	1.06	0	1	1.49	0.67	1	0.87	1.14	2	3.65	0.55
	P	0	0.45	0	0	1.10	0	0	2.12	0	4	2.18	1.84	4	5.85	0.68
RESPIRATORY DISEASE ICD:4600-5199	F	0	0.07	0	0	0.11	0	0	0.14	0	0	0.12	0	0	0.45	0
	P	0	0.11	0	0	0.13	0	0	0.22	0	0	0.32	0	0	0.77	0
VIOLENT CAUSES ICD:8000-9999	F	0	1.55	0	1	1.09	0.92	1	0.51	1.97	0	0.12	0	2	3.26	0.61
	P	1	3.03	0.33	2	1.71	1.17	0	0.72	0	0	0.29	0	3	5.76	0.52

Notes: OBS = Number of deaths that occurred; EXP = Expected Number of Deaths Based Upon Ontario Average; O/E = Ratio of Observed to Expected
In the TOTAL Column, none of the ratios are significantly different from 1.0 (2-Tailed P > 0.05), except for ALL-CAUSE mortality among the firefighters.

TABLE 10: MORTALITY FOR FIREFIGHTERS AND POLICE OFFICERS COMPARED TO PROVINCIAL AVERAGE
MEN ON STAFF JANUARY 1, 1973 OR LATER, FOLLOWED FROM TIME OF FIRE TO DECEMBER 31, 1990

CAUSE OF DEATH	FORCE	YEARS SINCE HIRE														
		0 - 9			10 - 19			20 - 29			30 or More			TOTAL		
		OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E
ALL CAUSES	F-Y	1	0.06	17.5	0	0.16	0	2	0.71	2.81	0	0.11	0	3	1.04	2.90
	F-N	0	0.09	0	0	0.31	0	1	1.29	0.78	1	2.58	0.4	2	4.27	0.47
	P-Y	0	0.02	0	0	0.06	0	1	0.07	14.1	0	0	0	1	0.15	6.5
	P-N	0	0.66	0	0	2.31	0	0	2.46	0	7	5.00	1.4	7	10.4	0.67
ALL MALIGNANCIES	F-Y	1	0.01	130	0	0.03	0	2	0.22	9.11	0	0.04	0	3	0.30	10.1
	F-N	0	0.01	0	0	0.07	0	0	0.41	0	1	0.85	1.2	1	1.35	0.74
	P-Y	0	0	0	0	0.01	0	1	0.02	53	0	0	0	1	0.03	28.9
	P-N	0	0.07	0	0	0.52	0	0	0.73	0	2	1.61	1.2	2	2.93	0.68
DIGESTIVE CANCER ICD:150-159	F-Y	0	0.00	0	0	0.01	0	1	0.06	15.7	0	0.01	0	1	0.09	11.8
	F-N	0	0.00	0	0	0.02	0	0	0.12	0	0	0.25	0	0	0.39	0
	P	0	0.01	0	0	0.15	0	0	0.22	0	0	0.47	0	0	0.85	0
RESPIRATORY [1] CANCER ICD:160-165	F-Y	0	0.00	0	0	0.01	0	0	0.08	0	0	0.01	0	0	0.10	0
	F-N	0	0.00	0	0	0.02	0	0	0.18	0	1	0.47	2.1	1	0.67	1.49
	P	0	0.01	0	0	0.14	0	0	0.27	0	0	0.64	0	0	1.05	0
CIRCULATORY DISEASE ICD:3900-4599	F-Y	0	0.01	0	0	0.04	0	0	0.27	0	0	0.03	0	0	0.35	0
	F-N	0	0.01	0	0	0.09	0	0	0.59	0	2	1.75	1.1	2	2.45	0.82
	P	0	0.05	0	0	0.72	0	0	0.99	0	4	2.29	1.7	4	4.06	0.99
ISCHEMIC HEART DISEASE ICD:4100-4149	F	0	0.00	0	0	0.10	0	0	0.68	0	1	1.30	0.8	1	2.10	0.48
	P	0	0.03	0	0	0.53	0	0	0.77	0	3	1.69	1.8	3	3.04	0.99

Continued Next Page

TABLE 10: MORTALITY FOR FIREFIGHTERS AND POLICE OFFICERS COMPARED TO PROVINCIAL AVERAGE
MEN ON STAFF JANUARY 1, 1973 OR LATER, FOLLOWED FROM TIME OF FIRE TO DECEMBER 31, 1990

CAUSE OF DEATH	FORCE	YEARS SINCE HIRE														
		0 - 9			10 - 19			20 - 29			30 or More			TOTAL		
		OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E	OBS	EXP	O/E
RESPIRATORY DISEASE ICD:4600-5199	F	0	0.00	0	0	0.01	0	0	0.06	0	0	0.25	0	0	0.33	0
	P	0	0.01	0	0	0.06	0	0	0.07	0	0	0.32	0	0	0.46	0
VIOLENT CAUSES ICD:8000-9999	F	0	0.09	0	0	0.14	0	1	0.23	0	0	0.14	0	1	0.61	0
	P	0	0.45	0	0	0.68	0	0	0.35	0	0	0.19	0	0	1.67	0

Notes: F-Y = Fire Department Present at Fire; F-N = Fire Department Not Present at Fire;
P-Y = Police Department Present at Fire; P-N = Police Department Not Present at Fire;
OBS = Number of deaths that occurred; EXP = Expected Number of Deaths Based Upon Ontario Average; O/E = Ratio of Observed to Expected

Table 11: Mortality Among Firefighters at Horticultural Technologies Fire Compared with Mortality Prior to Fire and Compared with Mortality of Men Not at Fire			
Cause of Death	Risk for Firefighters at Fire *Compared with Time Period Prior to Fire*	Lower 95% Confidence Interval[1]	Upper 95% Confidence Interval[1]
All Causes	6.46	1.39	29.9
All Malignancies	29.8	0.36	1564
	Risk for Firefighters at Fire *Compared with Risk for Men not at Fire*[2]		
All Causes	6.16	0.41	73
All Malignancies	13.5	0.17	709
	Risk for Firefighters *Not at Fire*[2] *Compared with Time Period Prior to Fire*		
All Causes	1.04	0.22	5.81

NOTES: 1) Confidence Limits calculated by exact method based upon ratio of 2 SMRs.
2) Group of men not at fire includes firefighters who had left force prior to March, 1987.

Table 12: Cancer Risk Among Firefighters By Stage of HT Fire at Attendance

1) Early stage

AT STAGE	CANCER *No*	CANCER *Yes*
No	56	3
Yes	9	0

Relative Risk[1]	95% Confidence Limits
.00	.00 to 16.87

2) Freeburning Stage

AT STAGE	CANCER *No*	CANCER *Yes*
No	24	2
Yes	41	1

Relative Risk[1]	95% Confidence Limits
.30	.00 to 6.01

3) Smouldering Stage

AT STAGE	CANCER *No*	CANCER *Yes*
No	26	1
Yes	39	2

Relative Risk[1]	95% Confidence Limits
1.33	.07 to 82

[1] Relative Risk is the Risk of cancer among men *present at this stage of the fire* compared to men *not in attendance* at this stage of the fire.

Table 13: Cancer Risk Among Firefighters By Activity at HT Fire

1) Extinguishment

PERFORM ACTIVITY	CANCER *No*	CANCER *Yes*
No	27	2
Yes	38	1

Relative Risk[2]	95% Confidence Limits
0.36	.01 to 7.26

2) Light Overhaul

PERFORM ACTIVITY	CANCER *No*	CANCER *Yes*
No	40	2
Yes	25	1

Relative Risk[2]	95% Confidence Limits
.80	0.01 to 16.2

3) Heavy Overhaul

PERFORM ACTIVITY	CANCER *No*	CANCER *Yes*
No	45	1
Yes	20	2

Relative Risk[2]	95% Confidence Limits
4.39	0.22 to 271

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[2] Relative Risk is the Risk of cancer among men *performing this activity at the fire* compared to men *not performing this activity*.

Table 14: Cancer Risk Among Firefighters By Medical Symptoms

1) Burning Eyes

SYMPTOM	CANCER *No*	CANCER *Yes*
No	48	1
Yes	6	1

Relative Risk[3]	95% Confidence Limits
8.00	0.19 to 350

2) Cough

SYMPTOM	CANCER *No*	CANCER *Yes*
No	39	1
Yes	15	1

Relative Risk[3]	95% Confidence Limits
2.60	0.07 to 103

3) Nose / Lung Irritation

SYMPTOM	CANCER *No*	CANCER *Yes*
No	50	1
Yes	4	1

Relative Risk[3]	95% Confidence Limits
12.50	0.27 to 599

4) Others: None of the cancer victims reported other symptoms.

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[3] Relative Risk is the Risk of cancer among men *reporting these symptoms* compared to men *not reporting these symptoms*.

Table 15: Cancer Risk Among Firefighters By Other Medical Factors

1) Cigarette Smoking

SMOKER	CANCER *No*	CANCER *Yes*	Relative Risk[4]	95% Confidence Limits
NEVER	22	1		
CURRENT	7	0	0.00	---- to ----
FORMER	23	1	0.96	0.02 to 38

2) Visited a Physician After the Fire

VISIT?	CANCER *No*	CANCER *Yes*	Relative Risk[4]	95% Confidence Limits
No	52	1		
Yes	0	1	Relative Risk Cannot be Calculated because of 0 in denominator P-value for comparison: P < 0.001	

[4] Relative Risk is the Risk of cancer among men *with these factors* compared to men *not reporting these factors*.

TABLE 16: List of Chemicals Mentioned on Material Safety Data Sheets

1,1,1 Trichloroethane
2-Butoxyethanol
2-Ethoxyethyl Acetate
8 Hydroxyquinolin. Citrate
Acetic Acid
Acetone
Aluminum Sulphate
Aromatic Petroleum Hydrocarbons
Cadmium Mercury Sulfide
Cadmium Sulfoselenide Red
Carbon
Cresols
Cyclohexane
Dichloromethane
Dimethyl Phthalate
Ethanol
Ethyl Acetate
Ethyl Ethoxyproprionate
Ethylene Glycol
Ethylene Glycol Monobutyl Ether
Ethylene Glycol Monoethyl Ether Acetate
Ethylene Vinyl Acetate
Formaldehyde
Glucose Monohydrate
Glycol Ether
Hydrogen Chloride
Isobutane
Isobutyl Acetate
Isophorone
Isopropyl Alcohol
Ketone Imine
Lead Chromate/Sulfate
Methyl Chloroform
Methyl Ethyl Ketone
Methylene Chloride
Mineral Spirits
Monoazo Dyes
Organic Esters
Petroleum Distillate Spirits
Phenol
Phenol Sulphonic Acid
Polyisocyanurate
Polyoxyethylene-Polyoxypropylene Polymer
Polyurethane
Propane
Propylene Glycol
Quaternary Ammonium
Sodium Salts of Organic Acids
Sulphuric Acid
Textile Spirits
Toluene
Triarylmethane
Tributyl Phosphate
Trichlorofluoromethane
Triphenylmethane
Xanthene
Xylene

Table 17: Cancer Risk Observed in Various Cohorts of Firefighters

Fire Department	Number of Firefighters	Years Employed	Years of Follow-Up	SMR	95% Confidence Interval
Boston[1]	5655	< 1915 - 1975	1915 - 1975	86	77 - 95
Buffalo[2]	1867	< 1950 - 1979	1950 - 1979	109	88 - 132
Denmark[3]	886	< 1971	1970 - 1980	117	72 - 178
Edmonton and Calgary[4]	3328	< 1927 - 1987	1927 - 1987	126	102 - 155
San Francisco[5]	3066	< 1940 - 1970	1940 - 1982	95	84 - 108
Seattle[6]	2289	< 1945 - 1980	1945 - 1983	96	77 - 118
Toronto[7]	1832	< 1918 - 1953	1921 - 1953	96	63 - 141
Western Australia[8]	990	< 1939 - 1978	1939 - 1978	109	74 - 156
TOTAL				96	90 - 101
Kitchener Fire	227	< 1973 - 1990	1973 - 1990	108 (5 / 4.63)	35 - 252
Waterloo Police	706	< 1973 - 1990	1973 - 1990	87 (7 / 8.07)	35 - 178

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1) A. W. Musk et al. BJIM 1978; 35:104-108;
2) J.E. Vena et al. AJIM 1987;11:671-684;
3) E. Hansen BJIM 1990; 47:805-809;
4) T. Guidotti 1990 (Unpublished);
5) J. J. Beaumont et al. AJIM 1991; 19:357-372.
6) N. Heyer et al. AJIM 1990;17:493-504
7) E. Mastromatteo Arch Ind Hlth 1959;20:55-61.
8) E. Eliopoulos et al. BJIM 1984;41:183-187